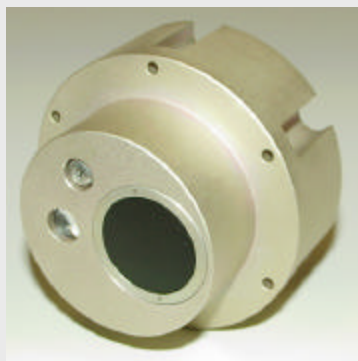
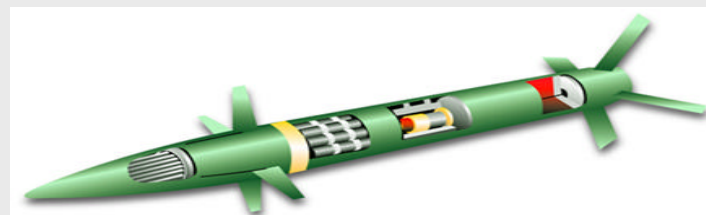
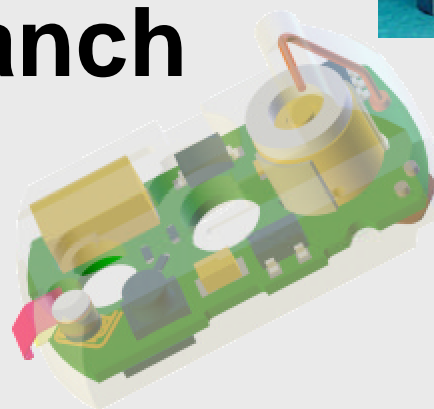
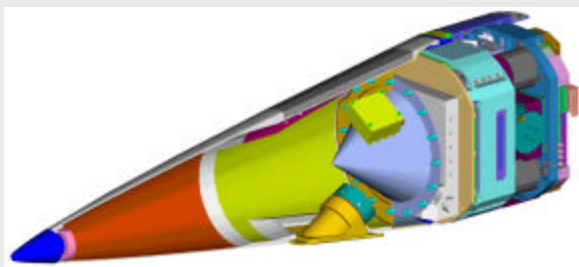
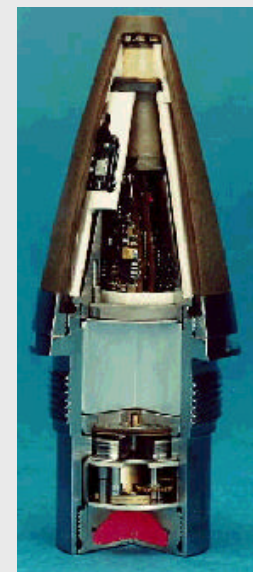




Fuzing at Dahlgren



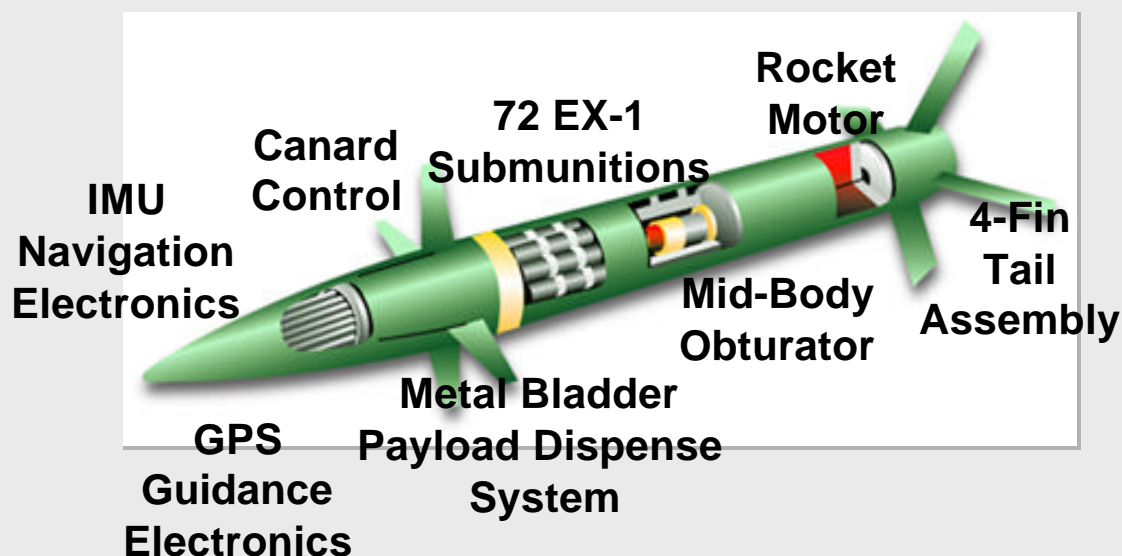
Michael A. Till
NSWC Dahlgren Division
G34, Fuze Branch



Report Documentation Page

Report Date 16Apr2001	Report Type N/A	Dates Covered (from... to) -
Title and Subtitle Fuzing at Dahlgren	Contract Number	
	Grant Number	
	Program Element Number	
Author(s) Till, Michael A.	Project Number	
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	Work Unit Number	
Performing Organization Name(s) and Address(es) NSWC Dahlgren Division	Performing Organization Report Number	
Sponsoring/Monitoring Agency Name(s) and Address(es) NDIA (National Defense Industrial Association) 211 Wilson BLvd., Ste. 400 Arlington, VA 22201-3061	Sponsor/Monitor's Acronym(s)	
	Sponsor/Monitor's Report Number(s)	
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Abstract		
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Report Classification unclassified	Classification of this page unclassified	
Classification of Abstract unclassified	Limitation of Abstract UU	
Number of Pages 44		

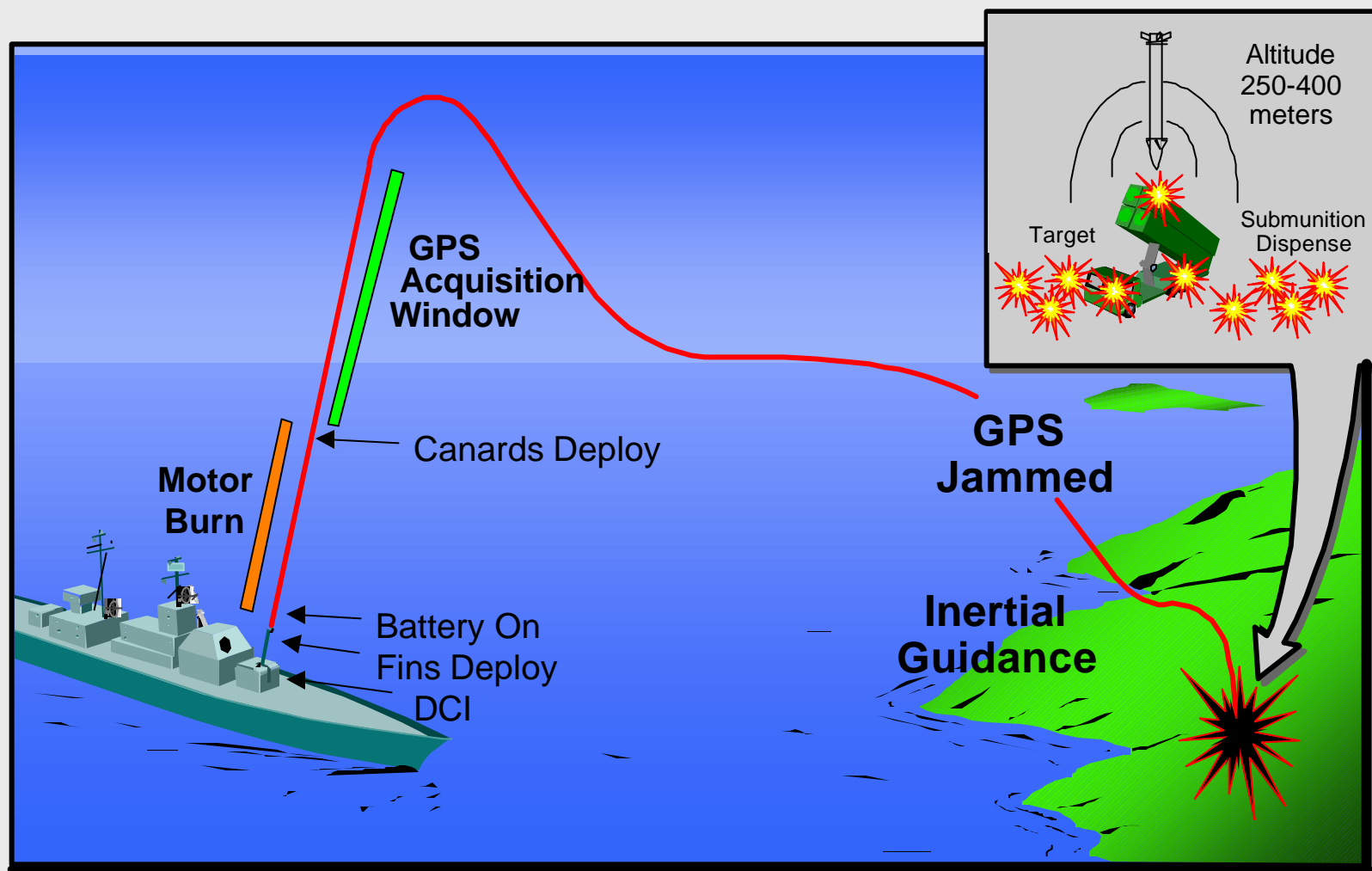
ERGM System Description



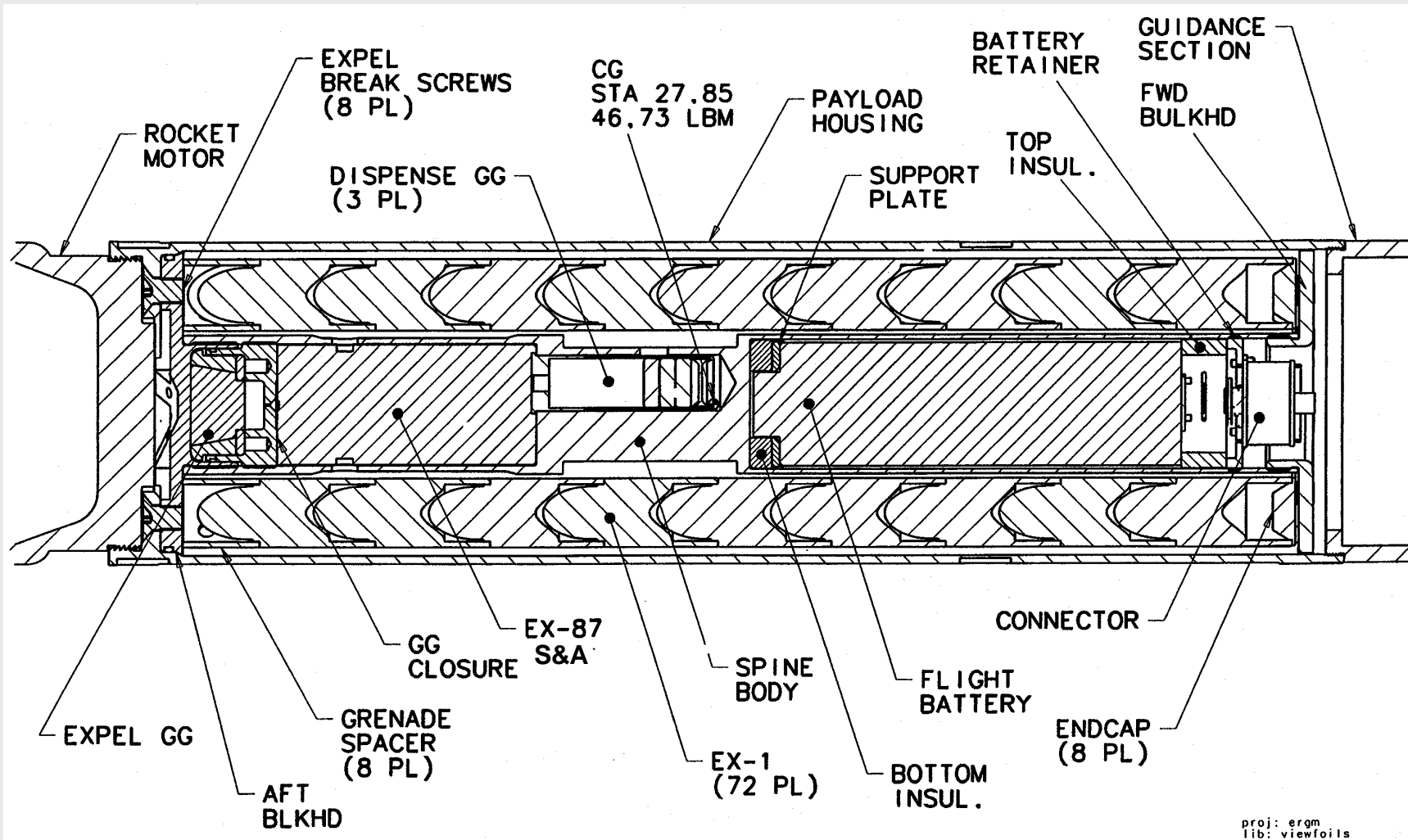
- Roll-Attitude Controlled Airframe
- Vertical Endgame Trajectory

- ❑ Length: 61 Inches
- ❑ Weight: 110 Pounds
- ❑ **Fuze: Integral, GPS Initiated**
- ❑ **Guidance: GPS/INS**
- ❑ Accuracy: <20m CEP
- ❑ Payload: Submunitions
 - 72 EX-1s (Modified M80s)
 - **Self Destruct Fuze (M234)**
- ❑ Propulsion: Rocket Motor
- ❑ Range Objective: 63 nmi
- ❑ Prop Charge: 18 MJ
- ❑ Loading: Double Ram

ERGM Mission Profile



ERGM Payload Section





ERGM Fuzing Status

❑ EX-87 Mod 1 S&A:

- Completed Design Validation Tests (DVT)
- Successfully Fired 3 in Canister Projectiles
- Successful Fired in Dynamic Dispense Air Drop Test (DD-1)
- Lessons Learned from DVT have been Incorporated

❑ Near Term Testing:

- S&A Qualification (July 01)
- Piston Actuator Component Qualification (June 01)
- Dynamic Dispense Gun Fire (May 01)

❑ M234 E1 Self-Destruct Fuze:



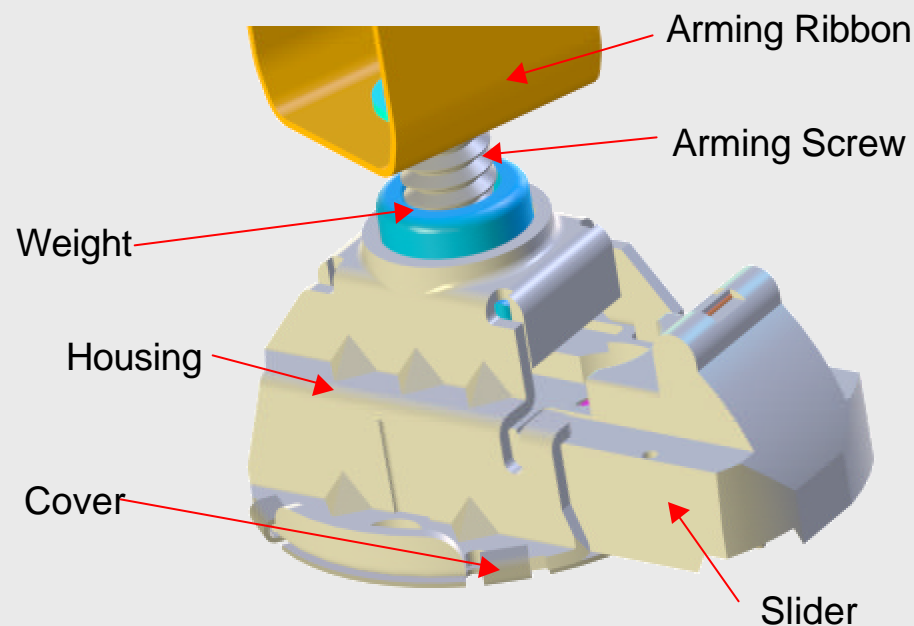
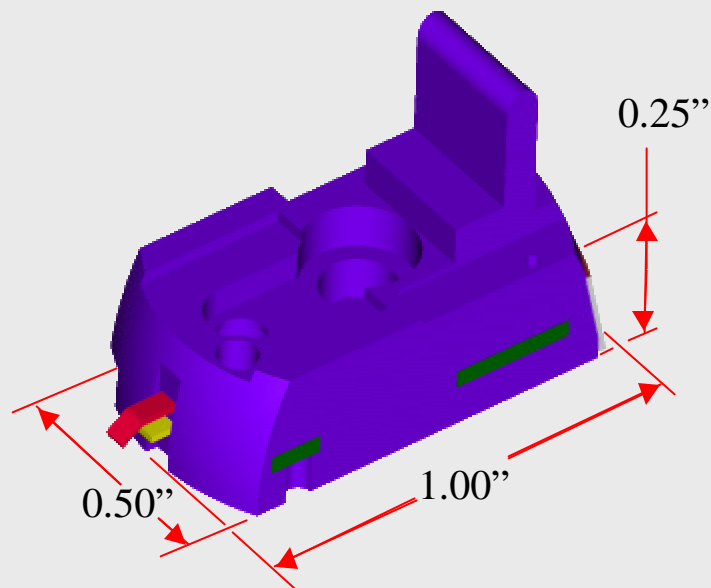
ERGM Fuzing Status

❑ M234 E1 Self-Destruct Fuze:

- DD-1 Test (YPG, 18 Aug 00)
 - Slight Over-Test Condition (Expel/Dispense Altitude Too Low)
 - 13 Primary Mode Failures (82% Successfully Armed)
 - 0 ERGM Shunt Removal Failures (100% Successfully Armed)
 - 14 Spiral Flag Failures (81% Successfully Armed)
- Additional Improvements Incorporated for Dynamic Dispense Gunfire Test (DD-2) Scheduled for early May '01

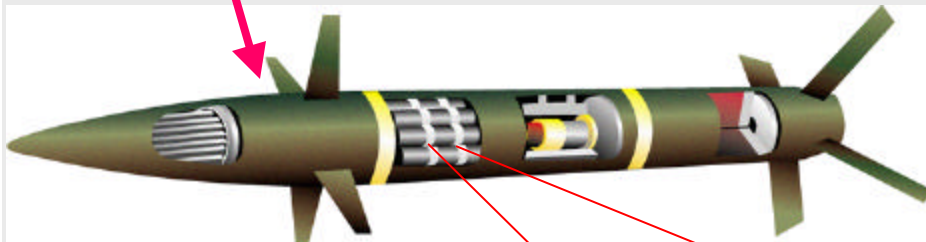
M80 PIP Objective

- To package the electronics and mechanical components of the Proximity Fuze in the shape and size of the current M234 SD Slider for the M80 Submunition for ERGM
 - One-for-One replacement of current Slider





MK 45 MOD 4



ERGM



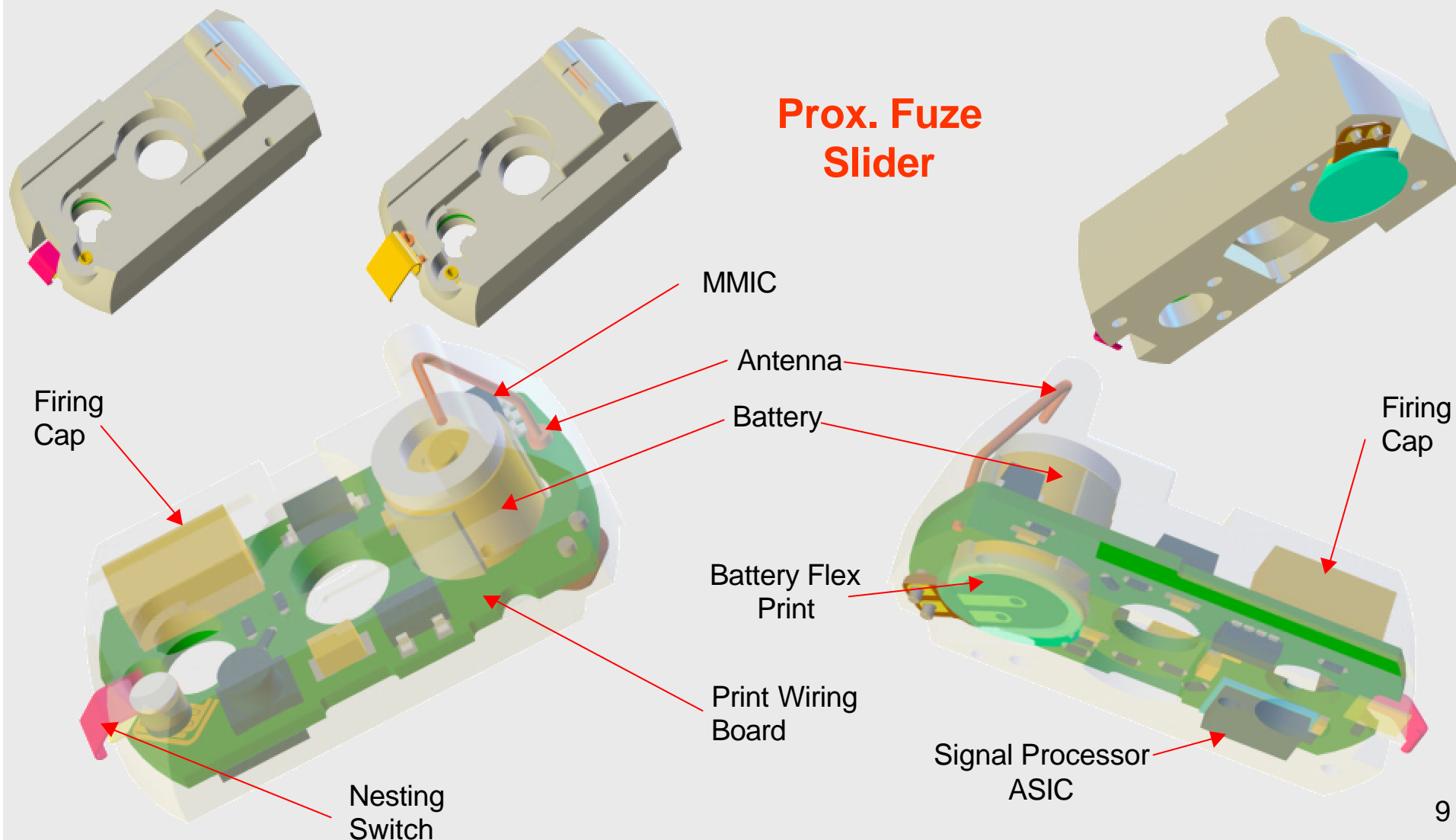
EX 3



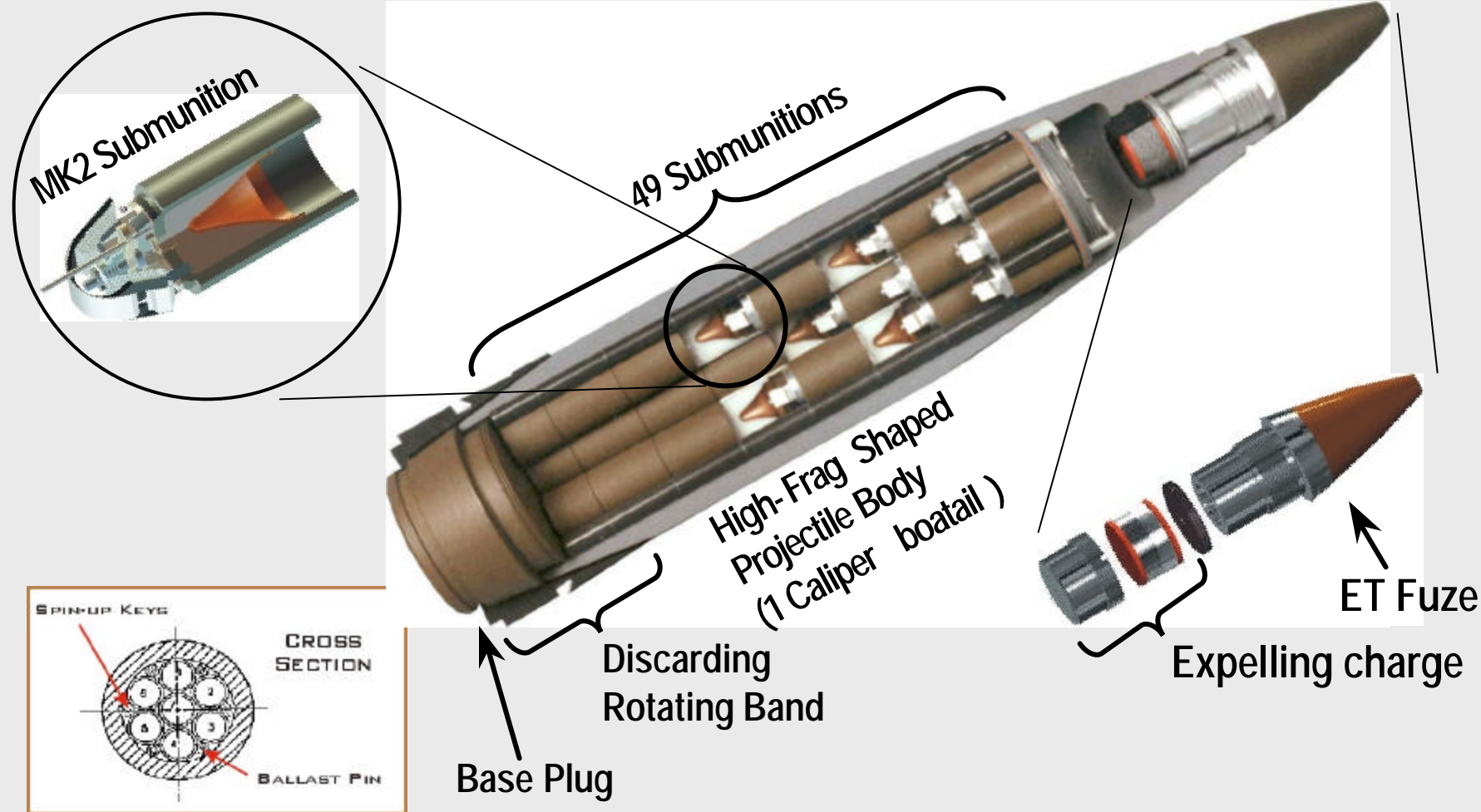
Proximity Fuze



Major Component Layout



Navy 5" Cargo Projectile





M80 Grenade Fuze, M223 Safety Modification

□ Design challenge:

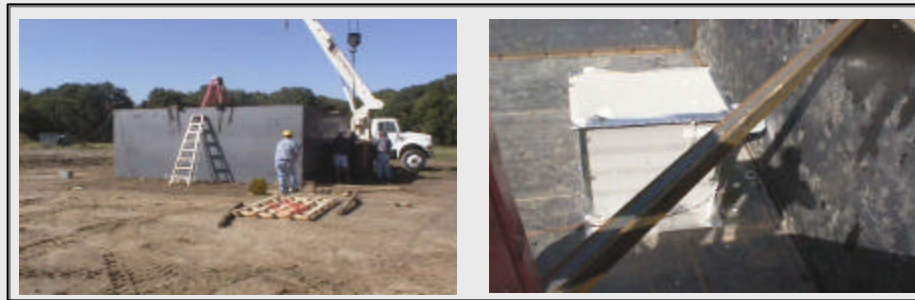
- Add a safety feature to the grenade for the 5” cargo round
- Minimal cost and ASAP - we’re already in production: 700,000 fuzes made
- Requirements driven from WSESRB letter (objective) & PEO “acceptance of risk” (threshold)



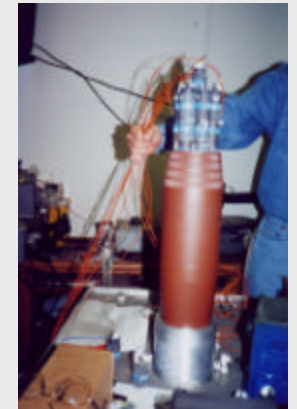
Resolution Efforts (Grenades already purchased)

Numerous add-on and redesign fixes were sketched and analyzed, then down selected a number of add-on fixes

Slow Cook-off Simulated Magazine Set-up



Thermocoupled Grenades



Shrink Tubing



Dayron Setback Clip

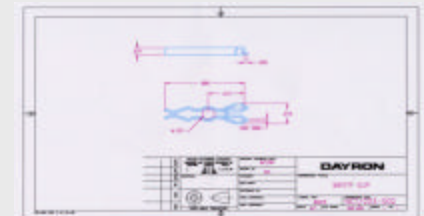


**Program has invested over
\$1.5M to date to resolve issue**

Dayron Dual Mode Clip



**Engineering
Concept**

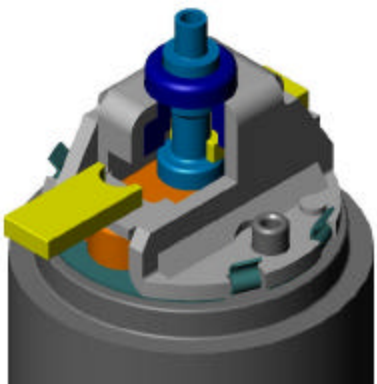


Metal spin clip line of designs
stopped by WSESRB letter 12



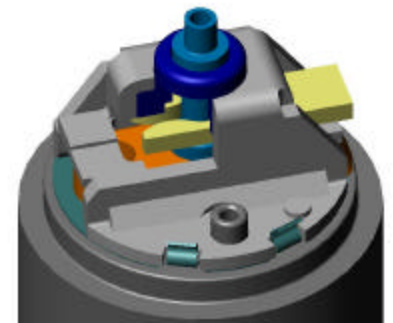
Resolution Efforts Downselect

**Dual
Meltable
Spin Locks**



- ❑ 1st tests show both significantly improve safety
- ❑ Solutions will meet 95% of the WSESRB concerns. May still leave 1 armed grenade plus 2 w/o an extra lock post cook-off
- ❑ Reliability testing and final downselect in May 01
- ❑ Cargo Program review at end of month. May change design course & require a 100% solution

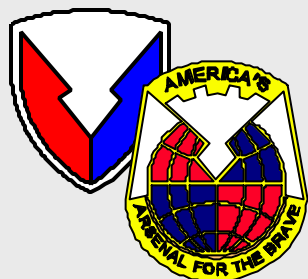
**Single
Meltable
Spin Lock**





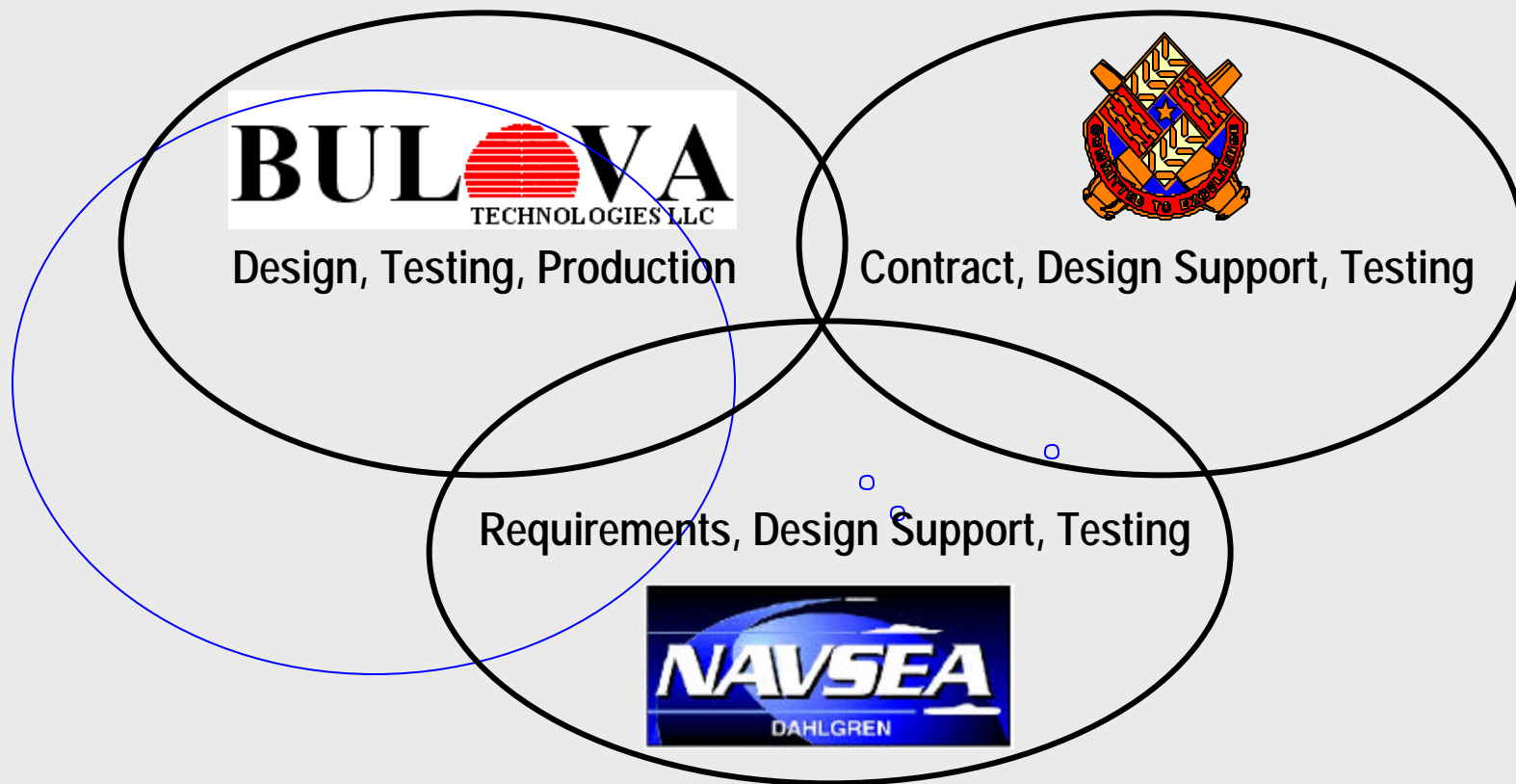
MK 432 ELECTRONIC TIME FUZE

A New Fuze for the US Navy





Team Approach





Navalization of the M762A1

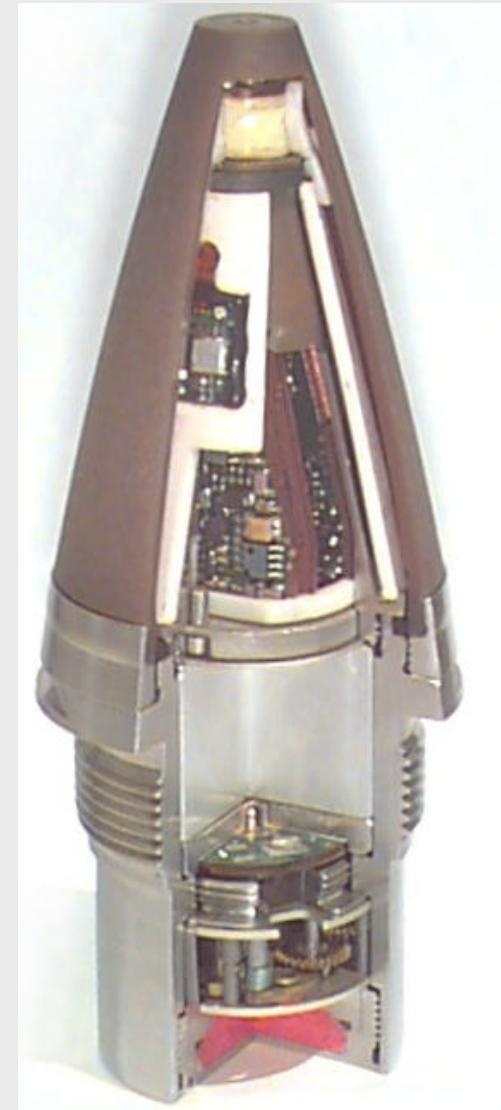
- ❑ **Inductive Set Compatibility**
- ❑ **Battery Activation**
- ❑ **Targets**
- ❑ **Remove PD back-up**
- ❑ **EEE improvements**
- ❑ **IM**



Qualification

- ❑ Completed in 9 months:**
 - 400 fuzes delivered**
 - Successful gun firings**
- ❑ Qualification Completed Summer 2001**
- ❑ Production Scheduled to begin July 2001**
- ❑ 14,600 Fuzes Delivered October 2001**

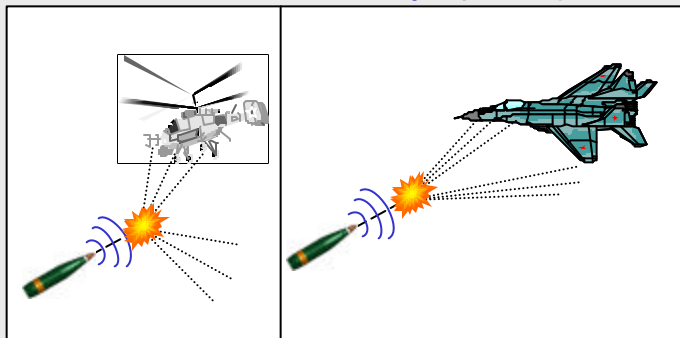
***M**ulti-**f**unction **F**uze (**MFF**)*



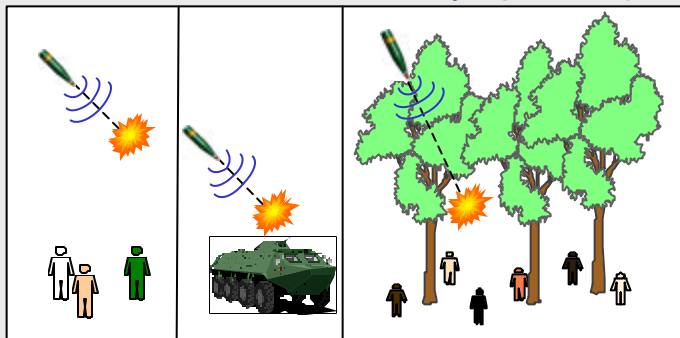


MFF Operational Modes

Air Proximity (AIR)



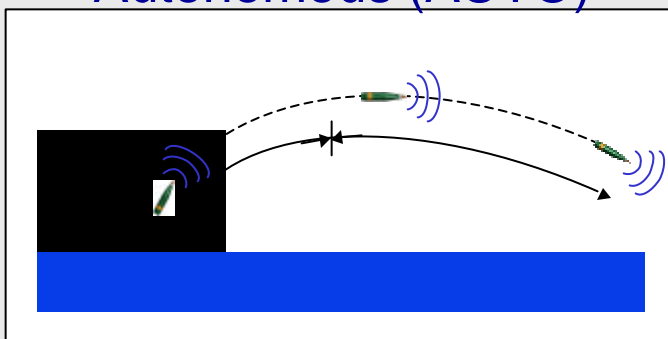
Surface Proximity (HOB)



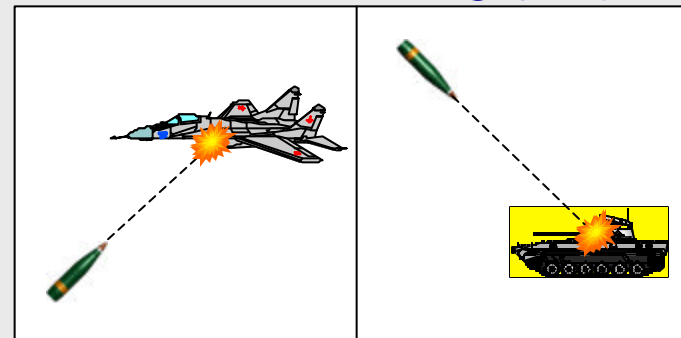
Replaces VT, CVT,
MT & PD fuzes on
HE rounds.
Simplifies logistics.
Uses IM Explosives.



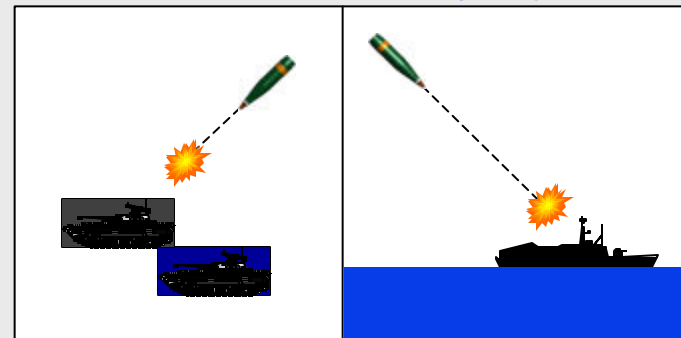
Autonomous (AUTO)



Point Detonating (PD)



Electronic Time (ET)



Multiplies effectiveness
of ship's magazine.
Improves fuze
performance, accuracy,
reliability & versatility.



MFF LRIP

- ❑ IPT: NSWC Dahlgren, NSWC Crane & ATK
 - Performance Specification
- ❑ Production at Alliant Precision Fuze Company, L.L.C in Janesville, WI
- ❑ LRIP ~9500 fuzes in 3 lots
- ❑ Options for another 6000 to 12000
- ❑ Pre-First Article performance
 - Twice as sensitive as MK 418 VT-RF fuze against the same air target
 - E&MD performance & production issues resolved



MFF Schedule

- ❑ New Program Schedule Approved
- ❑ Updating the ORD and TEMP
- ❑ TECHEVAL 3rd Qtr FY01
- ❑ OPEVAL 4th Qtr FY01
- ❑ Milestone III Decision 1st Qtr FY02
- ❑ LRIP 1st Lot delivered 2nd Qtr FY02
- ❑ IOC 1st HE-MF rounds delivered 2nd Qtr FY02
- ❑ FOT&E for 5in/62 Gun Qualification in FY02





MK 419 TECHEVAL

- ❑ San Clemente Island, SHOBA, 3rd Qtr FY01
- ❑ USS Bunker Hill (CG 52)
- ❑ 57 MK 419 Test rounds, 90 rounds total
- ❑ Part of First Article
- ❑ Test HOB, PD, ET, AUTO(HOB) performance over land and water





MK 419 OPEVAL

- ❑ San Clemente Island, SHOBA, 4th Qtr FY01
- ❑ USS Bunker Hill (CG 52)
- ❑ 170 MK 419 Test rounds, 200+ rounds total
- ❑ Test AIR, HOB, PD, ET, AUTO(HOB),
AUTO(AIR) performance over land and water
- ❑ Towed RF air target



MFF Cost Reduction RF System



- ❑ MMIC Receiver
 - Plastic encapsulation vs. ceramic pkg
 - Adjust frequency to reduce tuning effort
 - Align with optimum antenna and transmitter frequencies
- ❑ MMIC Transmitter
 - Plastic encapsulation
 - Frequency tweak if required
- ❑ Antenna
 - Improve dielectric material properties to enhance producibility
 - Decrease raw material cost



MFF Cost Reduction Battery

- ❑ Use MOFA battery with minimal modification
 - Failed to meet performance requirements
- ❑ European battery conference held to identify potential battery sources

Technical Objectives

- ❑ Develop an alternative Low Cost Guidance Electronics Unit (LCGEU) for the EX171 Extended Range Guided Munition (ERGM)
 - design as a form, fit, & function replacement for existing ERGM GEU
 - identify & select performance trades versus affordability
 - demonstrate performance via a series of guided flight tests

**LOW
COST
GEU**

*Form, Fit, Function GEU
replacement for EX-171*





Technical Objectives (Contd)

- Prepare for transition to future EMD phase
 - Work closely with Rockwell / Collins (EMD prime) to develop cost as independent variable in LCGEU design
 - Deliver complete HW/ SW documentation package
 - Identify future production cost reduction opportunities

**LOW
COST
GEU**

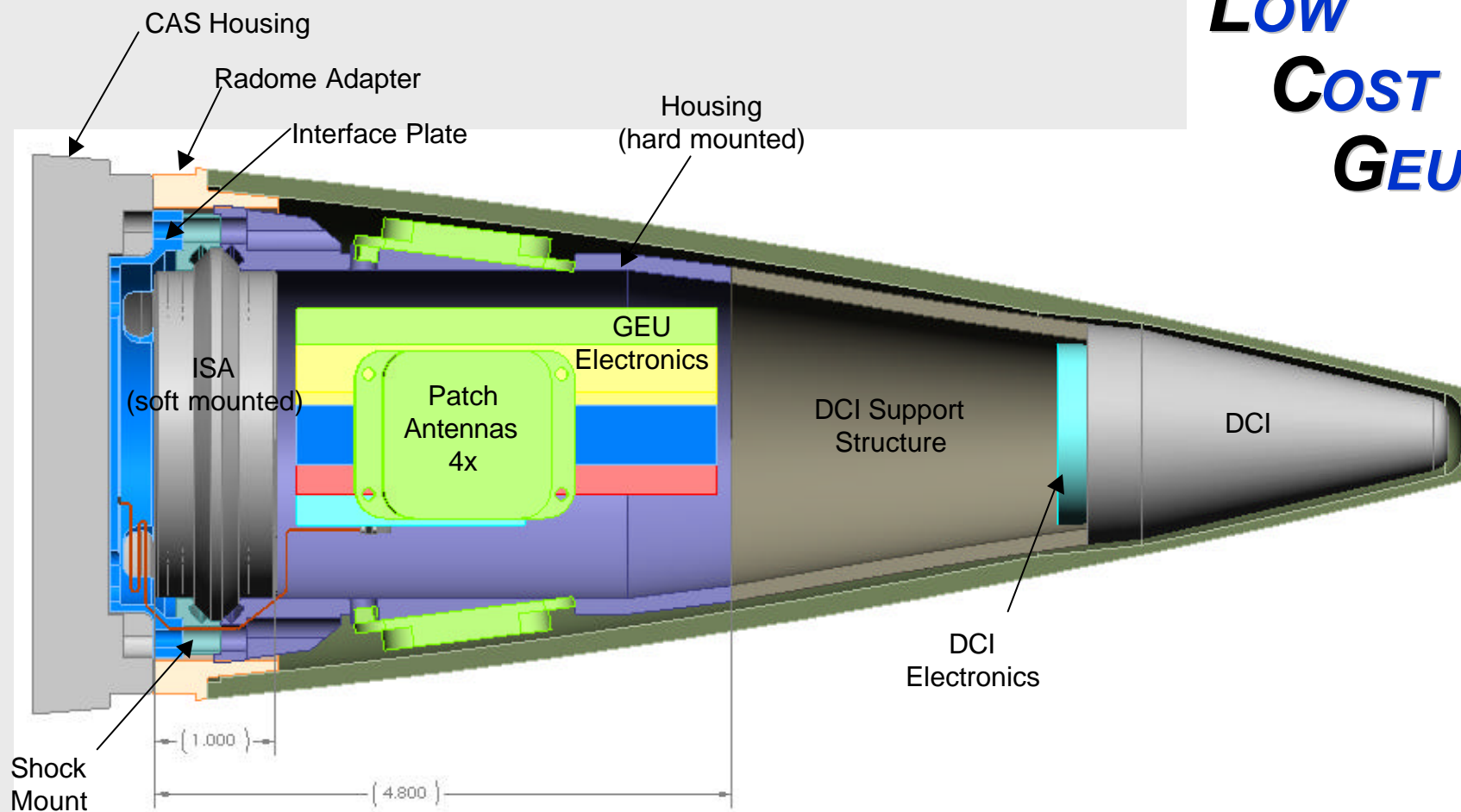
*Form, Fit, Function GEU
replacement for EX-171*



Draper Proprietary

Baseline Mechanical Design

**LOW
COST
GEU**





Standard Missile - 4 Height of Burst Fuze

Integrated Product Team (IPT) Assembled to Select a Height of Burst (HOB) Sensor and Incorporate as Primary Fuze for LASM

Raytheon

- HOB IPT LEAD
- MISSILE DESIGNER

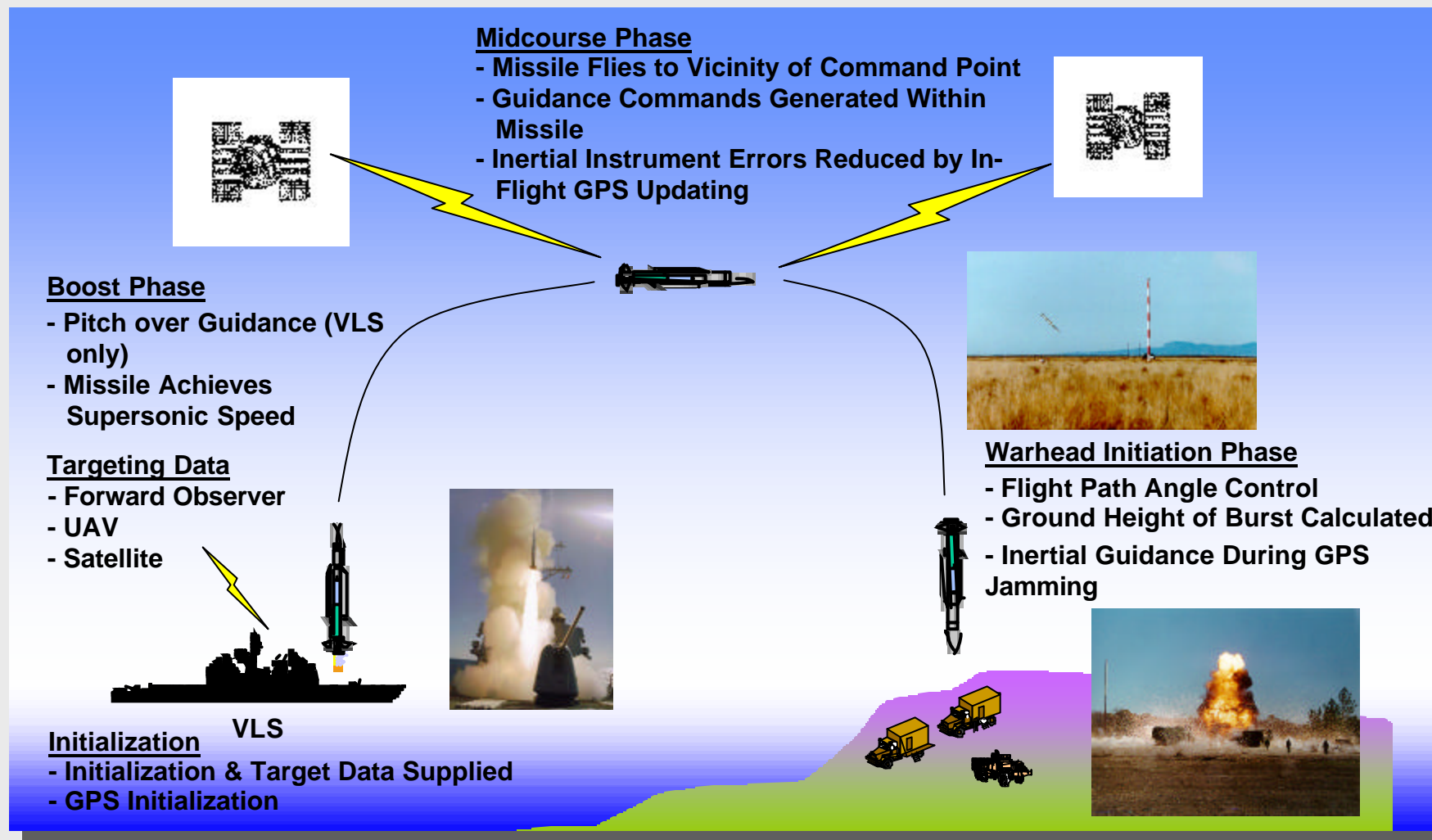


- TDA, REQUIREMENTS DEFINITION
- MODELING, TESTING



- GOVERNMENT FUZE EXPERT
- BAA

Mission Overview





HOB Sensor Selection

❑ Identify Candidate Sensors

- Broad Agency Announcement (BAA)
- Previous Trade Studies
- Recommendations from Team Members
- 18 Sensors from 12 Vendors Identified

❑ Sensors Fell into 3 Classes: Radio Frequency, Electro-Optical, Mechanical

❑ Down-select to Set of Sensors Meeting Minimum Requirements

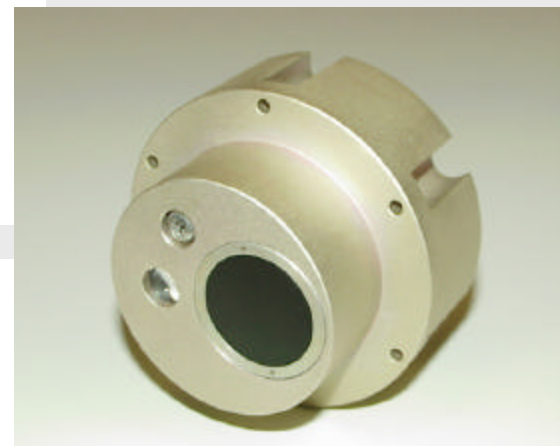
❑ Used Quality Functional Deployment Matrix for Comprehensive Comparison of Down-selected Sensors

- Evaluation Criteria Split Between Cost and Performance
- Relative Weights of Evaluation Criteria Determined by Team Consensus
- Scores Awarded Each Sensor Determined by Team Consensus

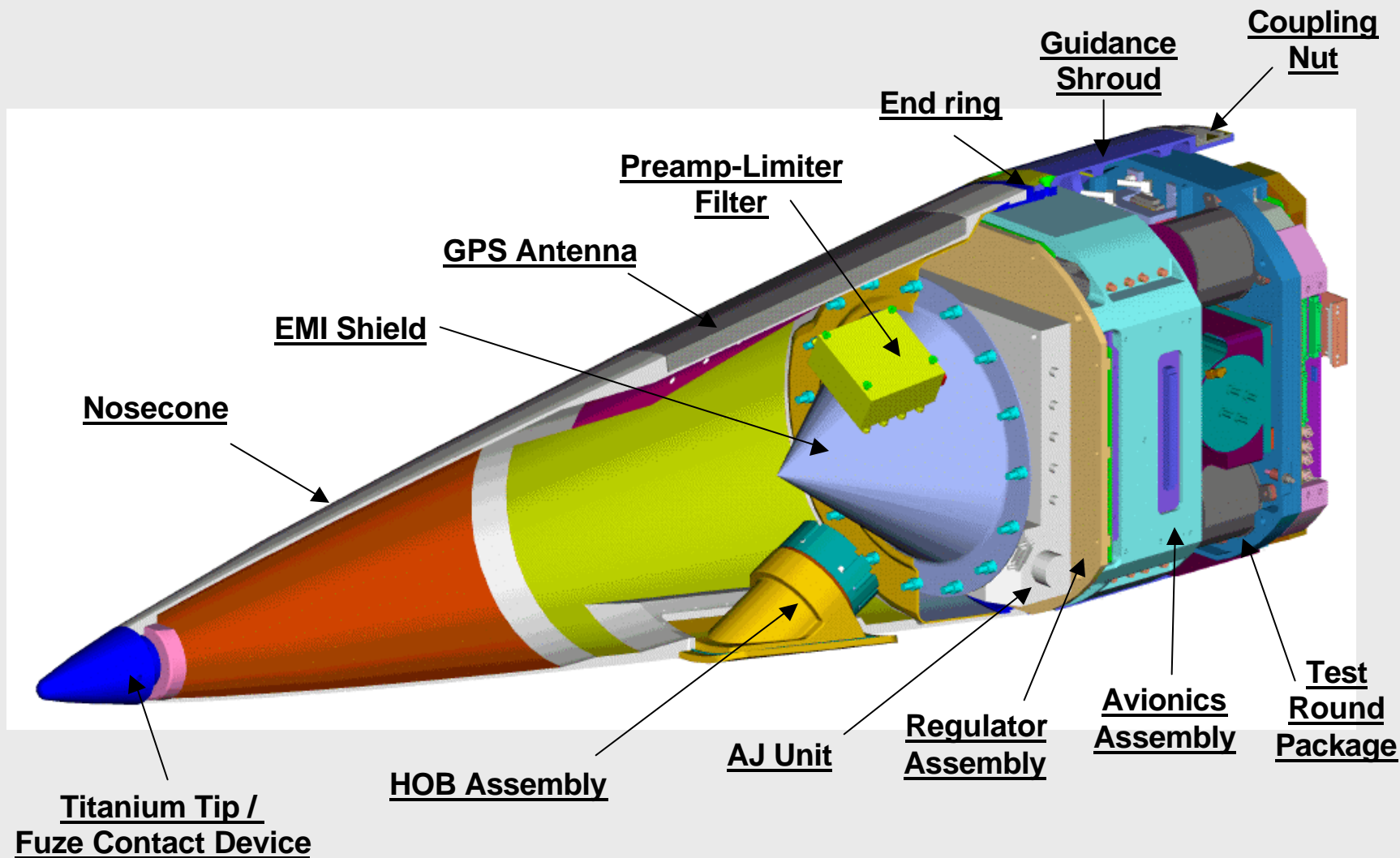
HOB Sensor

- ❑ Gen III - LASM Configuration
- ❑ Near IR Pulsed Diode Laser
- ❑ Low Cost, Rugged, Low Power, Array Logic, Microprocessor w/ EEPROM flash Memory, Serial Communication, Continuous Altitude readout, Obscurant Algorithms

- ❑ Gen III - Performance
- ❑ Cost Effective
- ❑ Will Meet Missile Environments
- ❑ Meets Clear Air Requirements
- ❑ Will Not Pre-trigger on Obscurant
- ❑ Will Distinguish Hard Targets from Obscurants
 - Degradation of Performance in Obscurants - TBD
- ❑ Mechanically and Electrically Interface with GS
- ❑ Adaptive Configuration for Future Growth



GUIDANCE SECTION ASSEMBLY





Summary

- ❑ Requirements Defined
- ❑ EO Sensor Characterized and Risks Identified With Mitigation Plans
- ❑ Preliminary Mechanical Design for HOB Main Assembly Complete
- ❑ Analysis and Test Performed



Future Efforts – Course Corrected Fuzes

- ❑ Trajectory error management
 - 1-D Corrections: drag chutes, drag fins, etc. to reduce range dispersion
 - 2-D Corrections: canards, pulse dots, etc. to reduce range dispersion and cross-track deflection
- ❑ Must not violate NATO standard fuze envelope during pre-flight
 - Ensures minimal impact on round handling equipment and procedures
 - MIL-STD-333B envelope selected
- ❑ Range increase not required
- ❑ Fielding by FY10



Future Efforts – Low Cost Projectile Fuze Alternatives

- ❑ Reduce Fuze Re-procurement Costs
 - Buy Fuzes with Army
 - Navalized MOFA
 - Buy Components with Army
 - Common S&A, battery, detonators
 - New Fuze
 - Low Cost Air Warfare Fuze
 - New Requirements



Issue #1: Batteries

- ❑ In the last few years, DOD has lost significant manufacturing and design ability to make batteries for gun fired munitions
 - Reduction in the last 10-15 years
 - Govt battery R&D personnel: approx 90% loss
 - Contractor companies: from 15 to 3
- ❑ The government has not maintained the expertise
- ❑ The contractors can not maintain the expertise
- ❑ No fundamental R&D conducted in the last 10 years in liquid reserve technology
- ❑ Applied chemical engineering has been conducted in a limited way on select programs with very limited success
 - Based on 15-20 year old technology



Impact to Navy Programs

❑ JMPSIB-IPT

- Dahlgren is the Navy's lead on the Joint Service IPT

❑ MK 419 MFF Battery

- MK 44 Lead-chemistry battery unproducible within USA
- No direct replacement
 - Lithium replacement program did not meet requirements
 - Investigating two European batteries
 - Lithium Chemistry
 - Lead Chemistry



Miniature Liquid RE

- ❑ EP, ATK, KDI have no success or limited experience in the cutting edge of power sources technology
- ❑ Major concern to ERGM program for both submunition programs
 - M234 SDF
 - EX 433 Prox Fuze



Objectives

❑ Current Navy Projectile Battery Requirements

- ERGM
 - 2 System batteries (1 thermal reserve, 1 liquid reserve)
 - 72 Submunition batteries
- MK 419 - MFF
- MK 418/MK 417 - VT-RF
- MK 404 - VT-IR
- EX 432 - ET

❑ Future Naval Gun launched projectiles requiring a power source

- GPS Rounds
- Best Buy - GPS, 100nmi
- Badger - GPS, Hypersonic projectile
- MRO Mission Responsive Ordnance
- AGS munitions



Issue #2: Submunitions

"On April 24, five children playing with colorful unexploded submunitions were reported killed, and two injured, near Doganovic in southern Kosovo."

-Steve Goose, program director of Human Rights Watch's arms division as reported in the Washington Post, Saturday, June 19, 1999; Page A19

"PRISTINA, Kosovo, May 22 -- One boy was killed and two other children were seriously wounded by a cluster bomb on Sunday..."

-Carlotta Gall; published on Tuesday, May 23, 2000 in the New York Times

"Submunition weapons employment in Southwest Asia and Kosovo, and major theater war modeling, have revealed a significant unexploded ordnance (UXO) concern."

-William Cohen, former U.S. Secretary of Defense in a memorandum dated 10 January, 2001





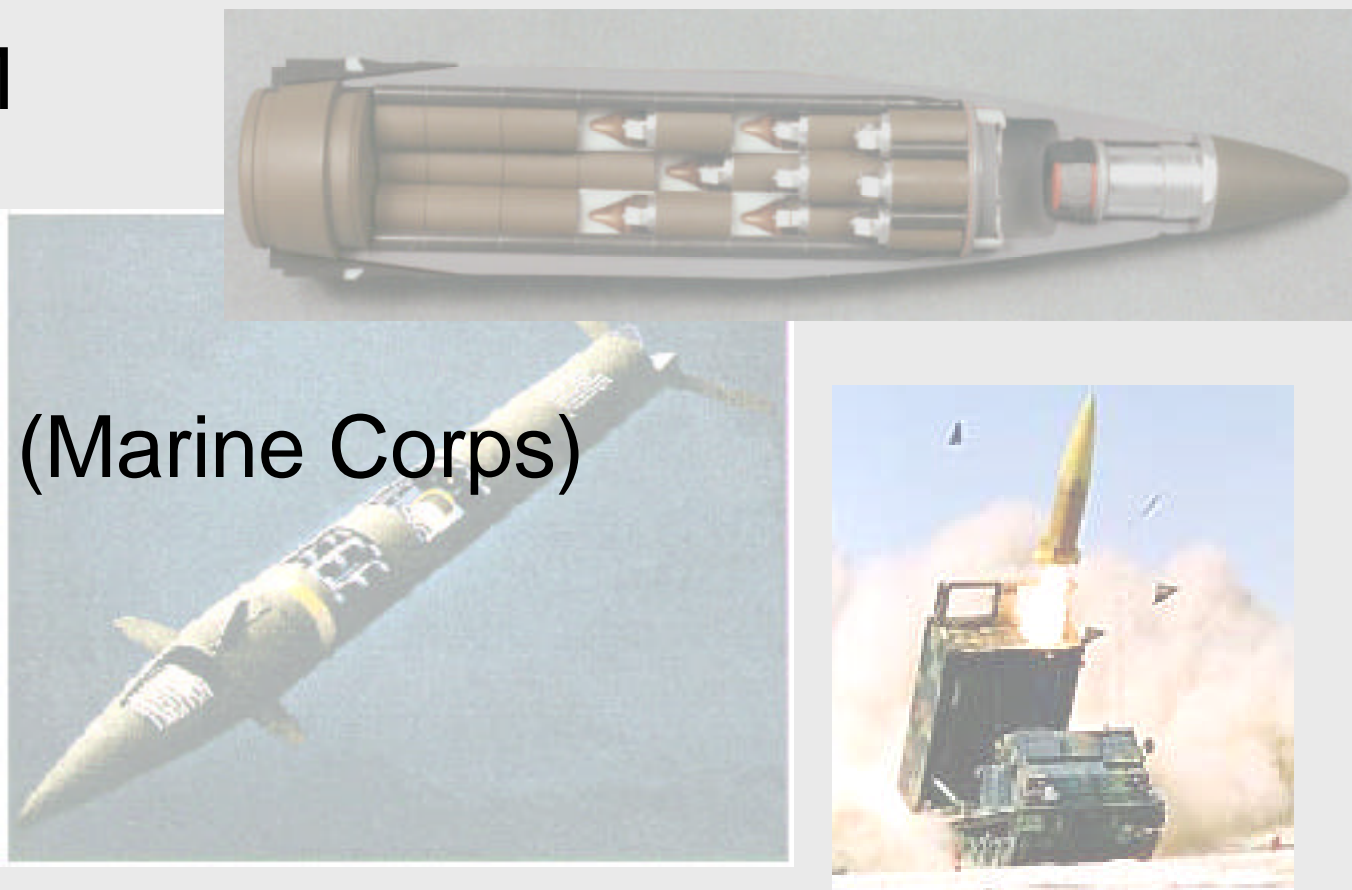
SecDef Memorandum

- ❑ “It is the policy of the DoD to reduce overall UXO...”
- ❑ “...the desire is to field future submunitions with a 99% or higher functioning rate.”
- ❑ “Submunition functioning rates may be lower under operational conditions...”
- ❑ “Services may retain ‘legacy’ submunitions...”
- ❑ “Waivers to this policy...shall require approval by the JROC.”

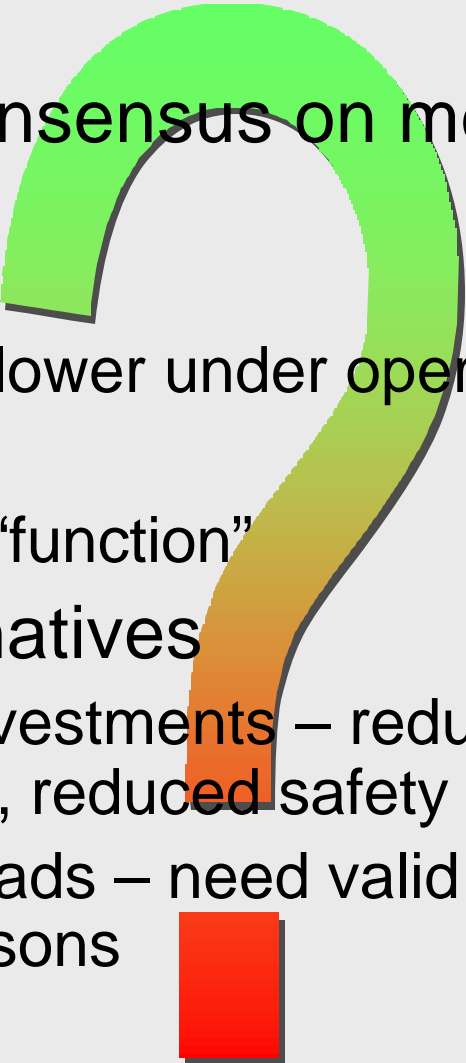


Navy Programs Affected

- ❑ ERGM
- ❑ Cargo
- ❑ MRO
- ❑ MLRS (Marine Corps)



What's Next?

- 
- Community Consensus on meaning of memorandum
 - “function”
 - “rates may be lower under operational conditions”
 - “waivers”
 - Safe UXO vs. “function”
 - Evaluate Alternatives
 - Technology Investments – redundancy, miniaturization, reduced safety
 - Unitary Warheads – need valid lethality models to make comparisons